

TOSHIBA

Overview of Industry Standards and Technical Publications Related to SF₆ Alternatives

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01 NEMA, JEMA, T&D Europe

02 ENTSO-E, Eurelectric

03 CIGRE – Council on Large Electrical Systems

04 IEC – International Electrotechnical Commission

05 IEEE – Institute of Electrical and Electronics Engineers

NEMA, JEMA and T&D Europe

SF₆ & ALTERNATIVES
COALITION

**Advantages of Shipping Gas-Insulated Equipment
with Dry Air**

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Alternative Insulation Technologies

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COALITION

Considerations for Planning an SF₆ Phase-Out



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Nameplate Adjustments
Recommended Processes to Support Accurate Reporting of SF₆ Emissions

NEMA US 80020-2022

Field Leak Detection of SF₆ Gas-Insulated Equipment

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COALITION

SF₆ Reporting Challenges

NEMA, JEMA and T&D Europe



The European Association of the Electricity Transmission and Distribution Equipment and Services Industry

POSITION PAPER

10 February 2020

T&D Europe position paper on SF₆ and SF₆ alternative technologies.



The European Association of the Electricity Transmission and Distribution Equipment and Services Industry

TECHNICAL REPORT

5th March 2020

Technical report on alternative to SF₆ gas in medium voltage & high voltage electrical equipment



The European Association of the Electricity Transmission and Distribution Equipment and Services Industry

POSITION PAPER

2021-05-24

T&D Europe confirms to support a transition towards SF₆-free alternative switchgear and equipment

JEMA along with other industry and academia propose seven requirements for SF₆ alternative solutions for power grids:

- 1. EHS – negligible EHS risks*
- 2. Service conditions – applicable to -25 deg. C outdoor temperature*
- 3. Stable supply – multiple suppliers, no regulatory risk*
- 4. Footprint – able to replace SF₆ equipment outdoor, indoor and underground*
- 5. Life cycle cost – similar to SF₆*
- 6. Gas handling – similar or improved compared to SF₆*
- 7. Rating coverage – scalable to 500 kV*

ENTSO-E Position Paper
on the reduction of SF₆ emissions and introduction of alternative technologies



ENTSO-E position paper on the reduction of SF₆ emissions and introduction of alternative technologies



Why the revision of the F-Gas Regulation is crucial for the reliability and safety of the power system

POSITION PAPER

Transition Times from SF₆ to alternative technologies for HV and EHV applications

ENTSO-E and T&D Europe, October 2021

Position papers written by European DSO and TSO organizations.

- *Transition to SF₆-free power grid*
- *Revision of the European F-gas regulation*

ENTSO-E's position on the F-Gas Regulation Revision



Ambitious emission reduction goals need a realistic approach

17 March 2023

CIGRE – Technical Brochures (reports)

589

The Impact of the Application of Vacuum Switchgear at Transmission Voltages

Working Group
A3.27

July 2014



- *Interruption physics compared to gas*
- *Fast dielectric recovery*
- *Improved electrical endurance*
- *Condition check*
- *Normal current limitations*
- *X-ray emissions*
- *NSDD's and their consequences*
- *ILS challenges and mitigation*
- *Capacitor bank switching challenges*

- *Electrical insulation properties under various conditions*
- *Quasi-uniform field*
- *Non-uniform field (e.g., particle)*
- *Surface roughness, area effects*
- *Gas pressure dependence*
- *V-t characteristics*

730

DRY AIR, N₂, CO₂ AND N₂/SF₆ MIXTURES FOR GAS-INSULATED SYSTEMS

WORKING GROUP
D1.51

JUNE 2018



CIGRE – Technical Brochures (reports)

B3

Substations and electrical installations

Application of non-SF₆ gases or gas-mixtures in medium and high voltage gas-insulated switchgear

Reference: 802



May 2020

- *Gas quality and purity requirements*
- *Aging aspects*
- *Gas handling and filling accuracy*
- *Tightness requirements*
- *Minimum functional gas composition*
- *HSE aspects*
- *Life-cycle aspects*

- *Global round-robin experimental campaign*
- *Variations of gas, gas mixture, pressure scheme*
- *Quasi-uniform, slightly inhomogeneous and highly inhomogeneous fields*
- *Data sufficient for statistical analysis*

D1

TECHNICAL BROCHURE

Materials and emerging test techniques

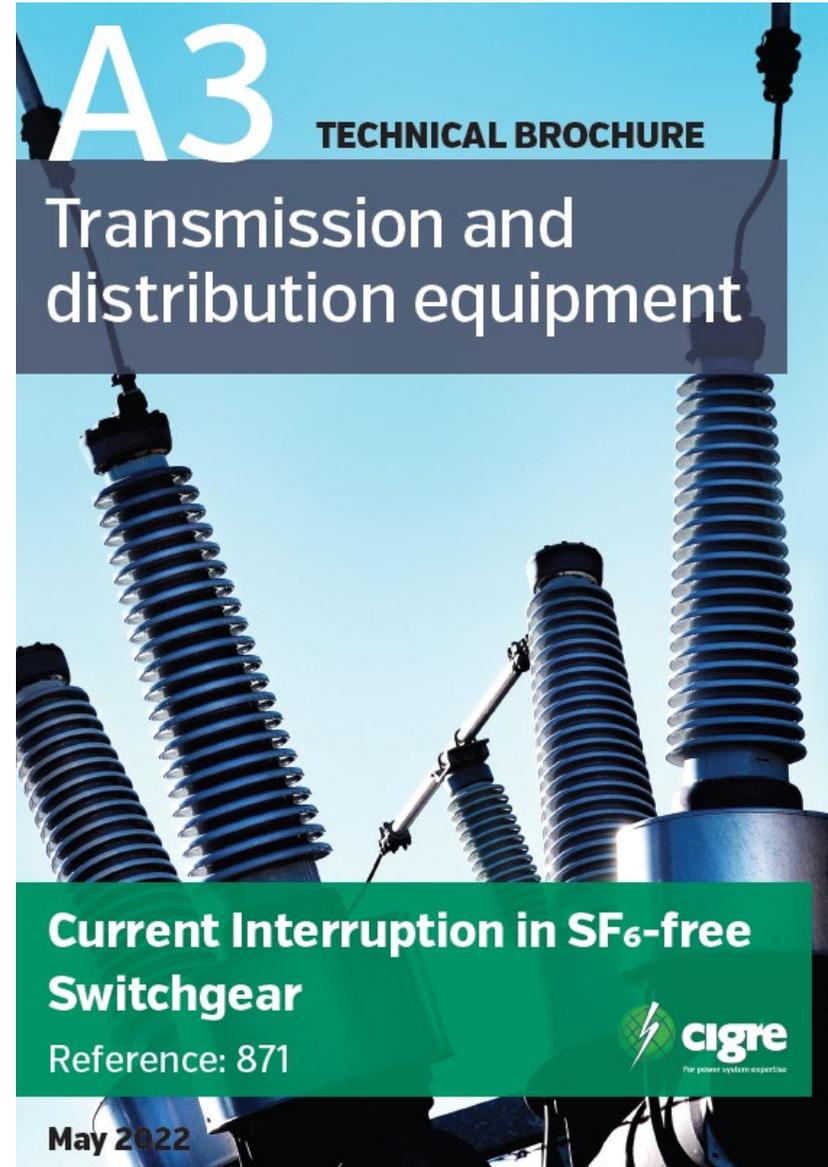
Electric performance of new non-SF₆ gases and gas mixtures for gas-insulated systems

Reference: 849



October 2021

CIGRE Technical Brochures (reports)



- *Thermodynamics of gas mixtures*
- *Gas interrupter parameters*
- *Lifetime aspects (tightness, decomposition)*
- *GIS DS, ES operation in gas*
- *Testing and standards*
- *HV vacuum*
- *New NV SF6-free*
- *Active SF6-free projects*
- *Ownership and operation*

- *Field gas handling*
- *Gas measurement guidance*
- *Gas tightness guide*
- *EHS aspects*
- *Recycling guidance*



CIGRE Study Committee B3

PROPOSAL FOR THE CREATION OF A NEW WORKING GROUP

JWG 1^N B3/A3.60	Name of Convenor: K.P. (Piet) Knol (Netherlands) E-mail address: piet.knol@tatasteleurope.com
Strategic Directions #²: 2, 3	Sustainable Development Goal #³: 12
The WG applies to distribution networks: <input checked="" type="checkbox"/> Yes / <input type="checkbox"/> No	
Potential Benefit of WG work #⁴: 1, 3, 4	
Title of the Group: User guide for non-SF6 gases and gas mixtures in Substations	



IEC 62271-4

Edition 2.0 2022-07

INTERNATIONAL STANDARD

NORME INTERNATIONALE



High-voltage switchgear and controlgear –
Part 4: Handling procedures for gases for insulation and/or switching

- *General information is in the body of the standard*
- *Annexes for specific gases and mixtures:*
 - *SF6*
 - *SF6 mixtures*
 - *Compressed air*
 - *Natural origin gases, mixtures*
 - *C5-FK mixtures*
 - *C4-FN mixtures*
 - *HFO1234zeE*

Coming Soon:

*IEC 62271-320 (technical specification)
High-voltage switchgear and controlgear – Part 320: Environmental
aspects and life cycle assessment rules*

Expected 2024

IEEE – Technical Reports and Guides

**Very broad technical report:
History and background
Technical, commercial and
standardization topics.**

IEEE Power & Energy Society
May 2018

TECHNICAL REPORT
PES-TR64

Impact of Alternate Gases
on Existing IEEE Standards

PREPARED BY THE
IEEE PES Switchgear Committee
IEEE PES ADSCOM Subcommittee
With support from the IEEE PES Substation Committee
IEEE PES Alternate Gases Task Force

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PC37.100.7/D4.2, May 2023
Draft Guide for the Evaluation of Performance Characteristics of Non-Sulfur Hexafluoride Insulation and Arc Quenching Media for Switchgear Rated above 1000 V

PC37.100.7™/D4.2

Draft Guide for the Evaluation of Performance Characteristics of Non-Sulfur Hexafluoride Insulation and Arc Quenching Media for Switchgear Rated above 1000 V

Developed by the

Switchgear Committee
of the
IEEE Power and Energy Society

Approved <Date Approved>

IEEE SA Standards Board

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Technical guide to inform test standards on the accommodation of SF6 alternatives in switchgear:

Gas mixtures
Gas tightness
Toxicity
Short circuit
Thermal

Decomposition
X-rays
GWP to LCA
Dielectrics
Low temp.

Guide for the handling of non-SF6 gases used in HV electric power equipment.

Scope includes new installations, maintenance, repair, overhaul, extension and decommissioning.

IEEE SA STANDARDS ASSOCIATION



PC37.122.10

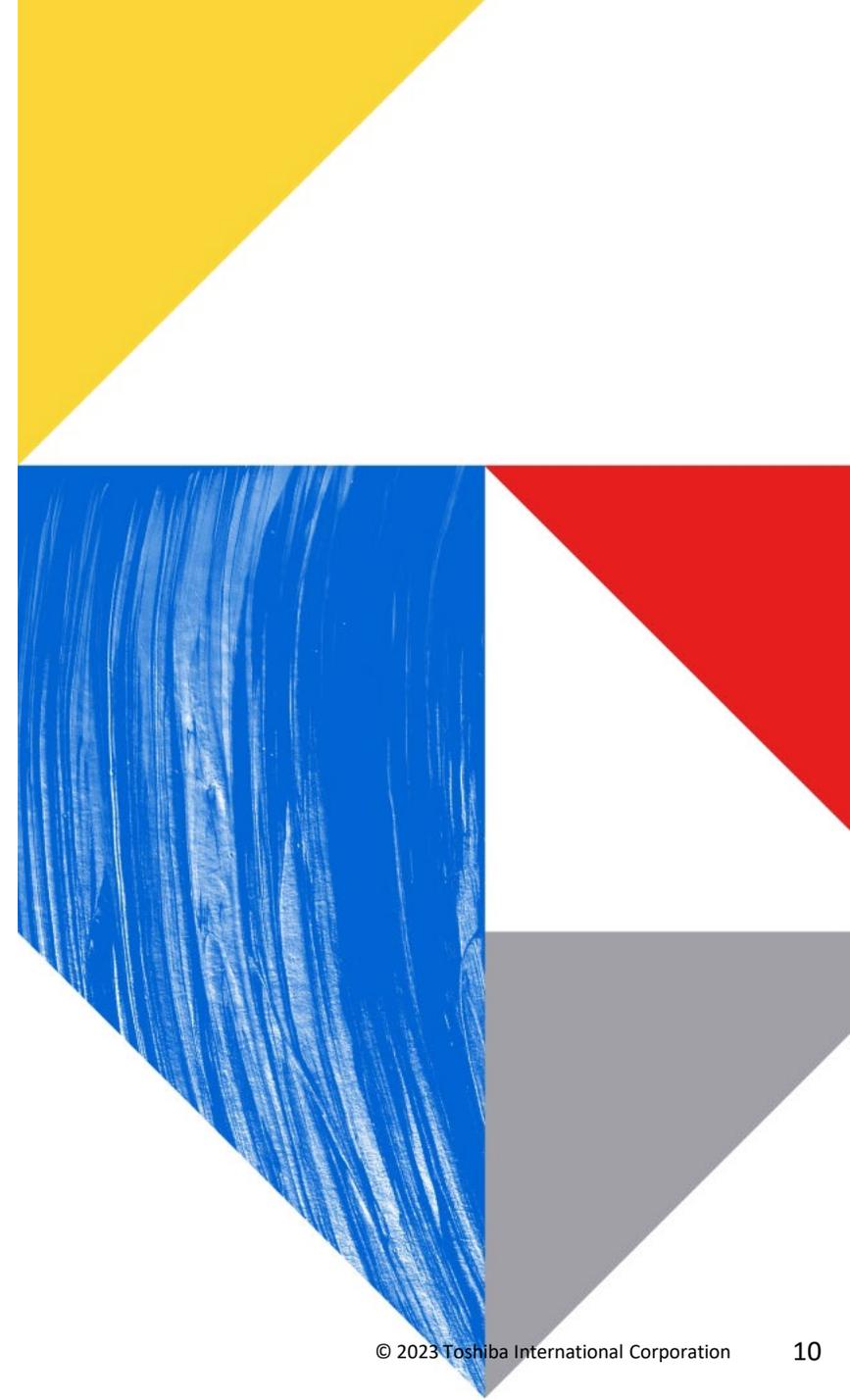
Type of Project: New IEEE Standard
Project Request Type: Modify / New
Project Request Date: 10 Jan 2023
PAR Approval Date: 30 Mar 2023
PAR Expiration Date: 31 Dec 2025
PAR Status: Active
Root PAR: PC37.122.10
Root PAR Approved on: 05 Sep 2019

1.1 Project Number: PC37.122.10
1.2 Type of Document: Guide
1.3 Life Cycle: Full Use

2.1 Project Title: Guide for Handling Non-Sulphur Hexafluoride (SF6) Gases for High-Voltage Equipment Rated above 1000 Vac

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Thank you



APPENDIX